AMRAD

Amateur Radio Research and Development Corporation

1524 Springvale Avenue
McLean, Virginia 22101
July 26, 1982

Dear Hank,

Some time ago, I sent you a complete set of AMRAD packet radio briefing transparencies. Enclosed is a revision of 82-31 to adjust frequencies per suggestions of Dave Sumner, K1ZZ. At the present, they represent only my personal nominations for packet frequencies. The lower frequency in each band is suggested for experimental/direct use between packet stations. The upper frequency in each band is suggested for network/traffic use whenever that gets under way.

Please let me have any artwork that you feel should be added to this set of transparencies, also any suggested improvements.

73,

Dave

Paul L. Rinaldo, W4RI

AMRAD

Amateur Packet Radio Activity

- Vancouver, BC (VE7CYB)
- Ottawa; ON (VE3QB)
- Washington, DC (K8MMO)
- Tucson, AZ (KD2S)
- Newington, CT (K1RT)
- Hamilton, ON (VE3MWM)
- Montreal, PQ (VE2PY)
- Toronto, ON (VE7APU)
- San Francisco (KA6M)
- New Jersey (W2FPY)
- Schenectady, NY (W20DC)
- St Louis (WB9FLW)

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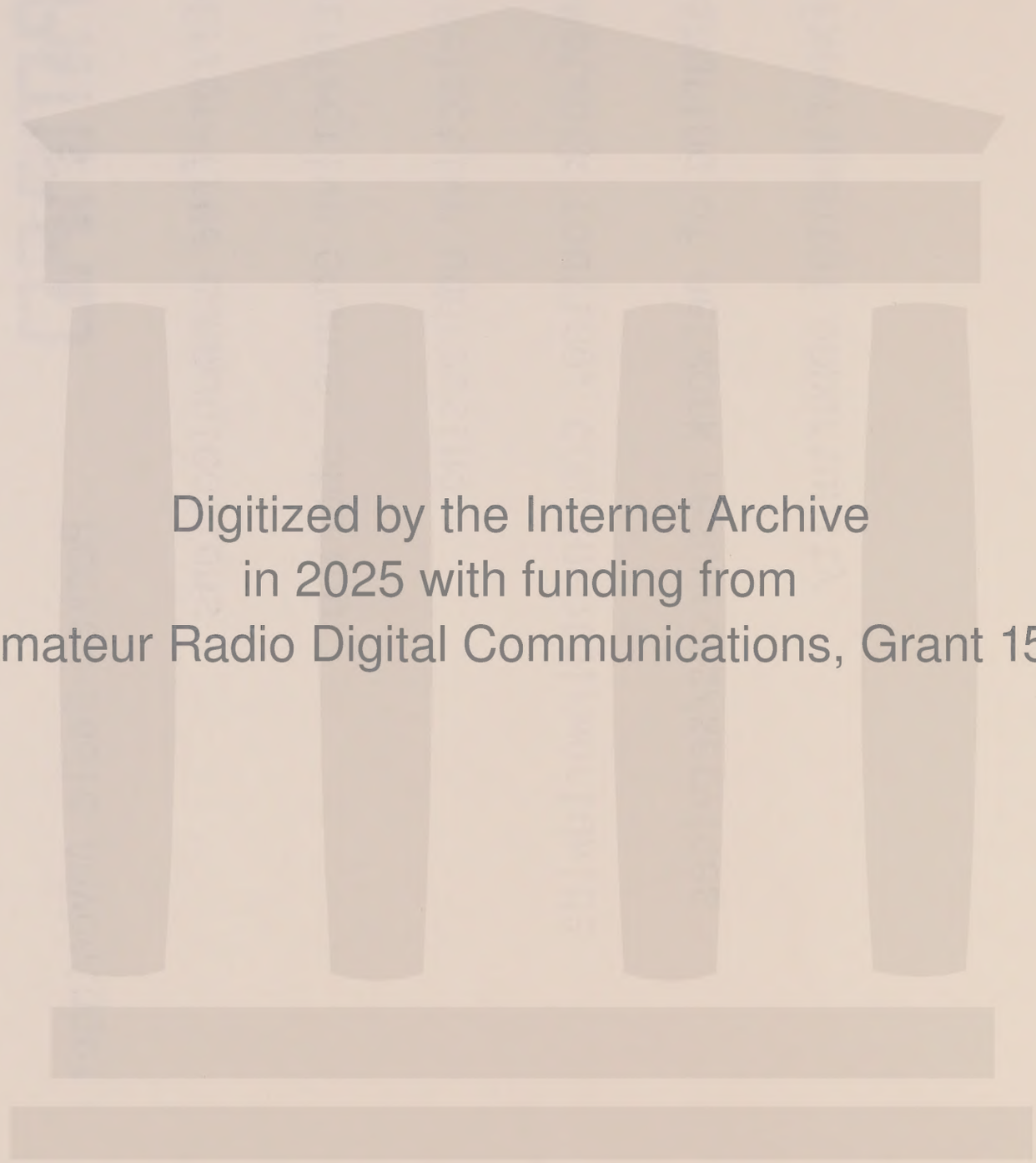
Packet Radio Advantages

- Error-free communications
- Effective channel sharing
- Selective addressing
- Network routing, continental/worldwide
- Sharing of network resources/services
- Experimental opportunity



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https://archive.org/details/amicon-ss-draft-rev-1.02

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Packet Radio Applications

Terminal to Terminal	QSO/Ragchew
Terminal to Host	QSTs Message orig. & delivery Remote programs (write/use) Data bases Games
Host to Host	File transfer Message transfer Batch processing

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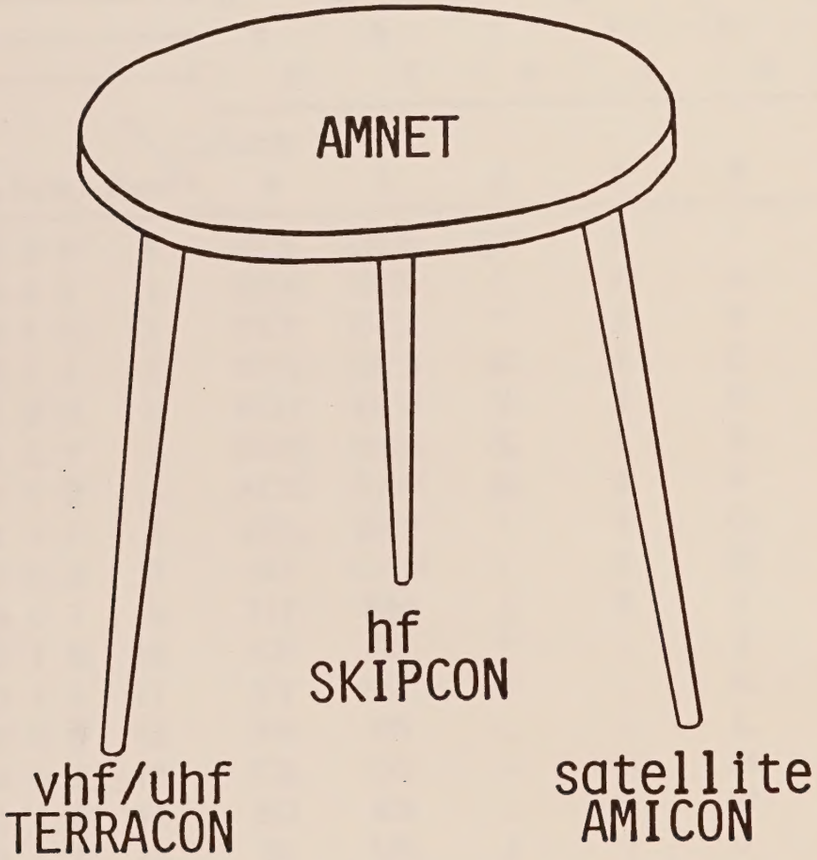
AMNET Media



AMRAD American Standard Code for Information Interchange (ASCII)

Bit Number															
								0	0	0	0	1	1	1	1
								0	0	1	1	0	0	1	1
								0	1	0	1	0	1	0	1
b_7	b_6	b_5	b_4	b_3	b_2	b_1	Row \ Column	0	1	2	3	4	5	6	7
0	0	0	0				0	NUL	DLE	SP	ø	‘	P	@	p
0	0	0	1				1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0				2	STX	DC2	"	2	B	R	b	r
0	0	1	1				3	ETX	DC3	#	3	C	S	c	s
0	1	0	0				4	EOT	DC4	$	4	D	T	d	t
0	1	0	1				5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0				6	ACK	SYN	&	6	F	V	f	v
0	1	1	1				7	BEL	ETB	’	7	G	W	g	w
1	0	0	0				8	BS	CAN	(	8	H	X	h	x
1	0	0	1				9	HT	EM	)	9	I	Y	i	y
1	0	1	0				10	LF	SS	*	:	J	Z	j	z
1	0	1	1				11	VT	ESC	+	;	K	⊏	k	{
1	1	0	0				12	FF	FS	,	<	L	~	l	¬
1	1	0	1				13	CR	GS	–	=	M	⊐	m	}
1	1	1	0				14	SO	RS	.	>	N	^	n	|
1	1	1	1				15	SI	US	/	?	0	–	o	DEL

AMRAD Start-Stop Character Structures

LETTER F IN 5-BIT TELEGRAPHY (CCITT ALPHABET N°2 OR BAUDOT CODE)

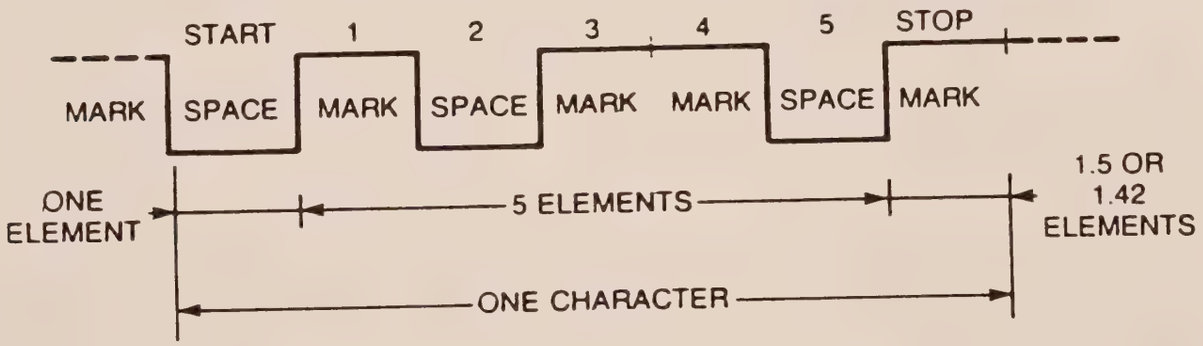
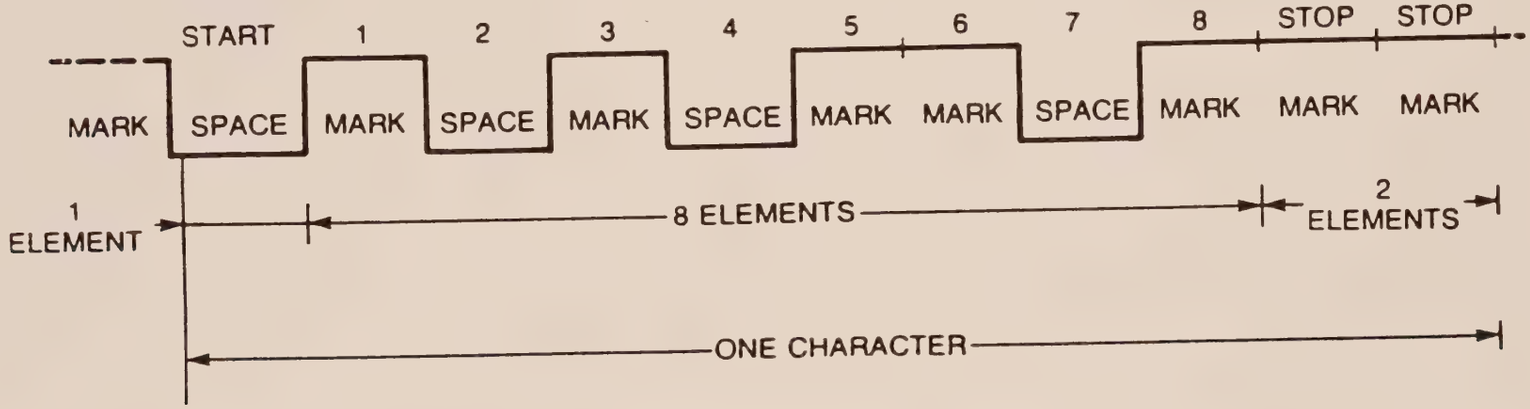


FIGURE 5 FOR 8-BIT TELEGRAPH MACHINES (CCITT ALPHABET N°5 OR ASCII CODE)



$$\text{BAUD RATE} = \frac{7.5}{5} \times \text{BIT RATE}$$

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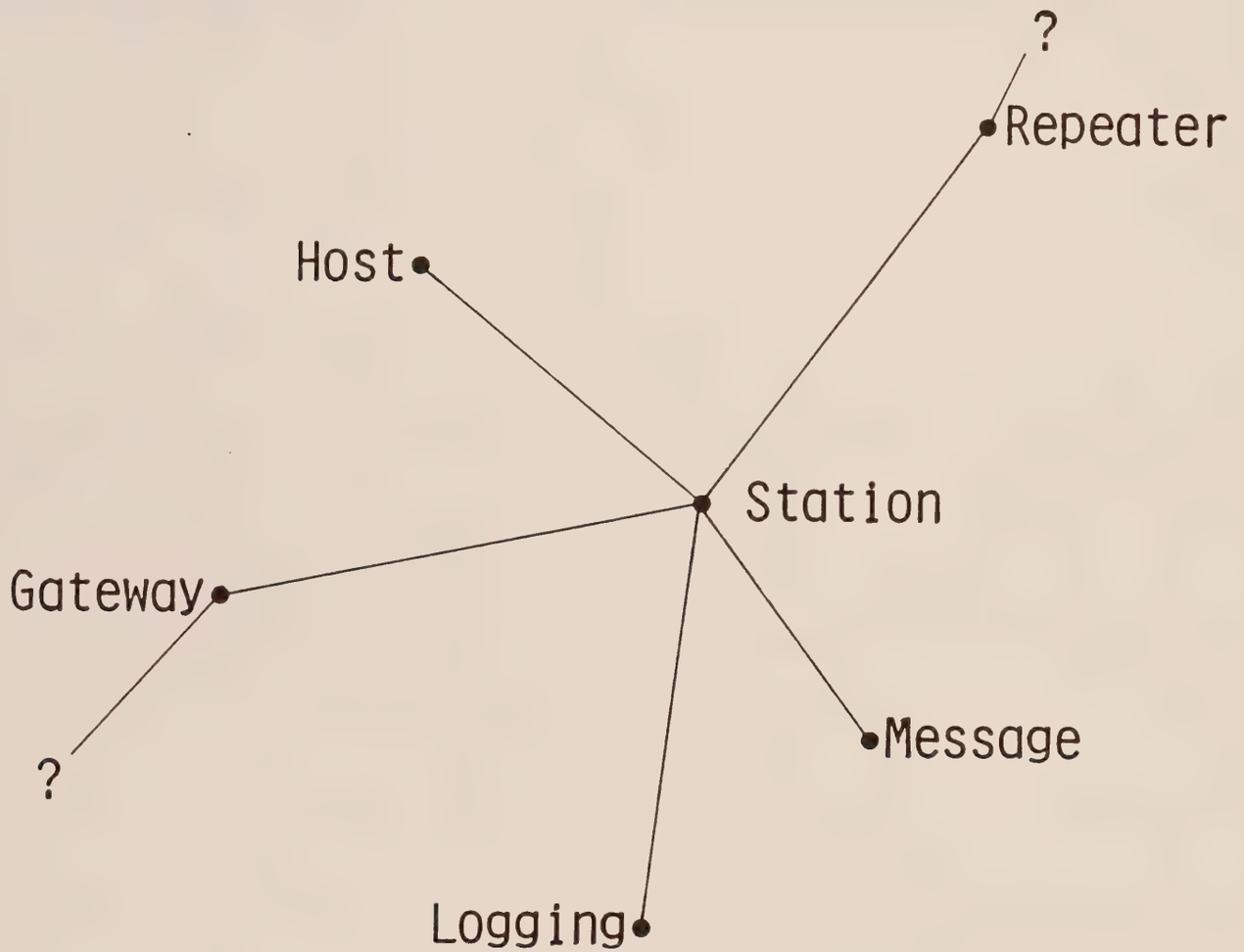
Types of Backbone Network Nodes



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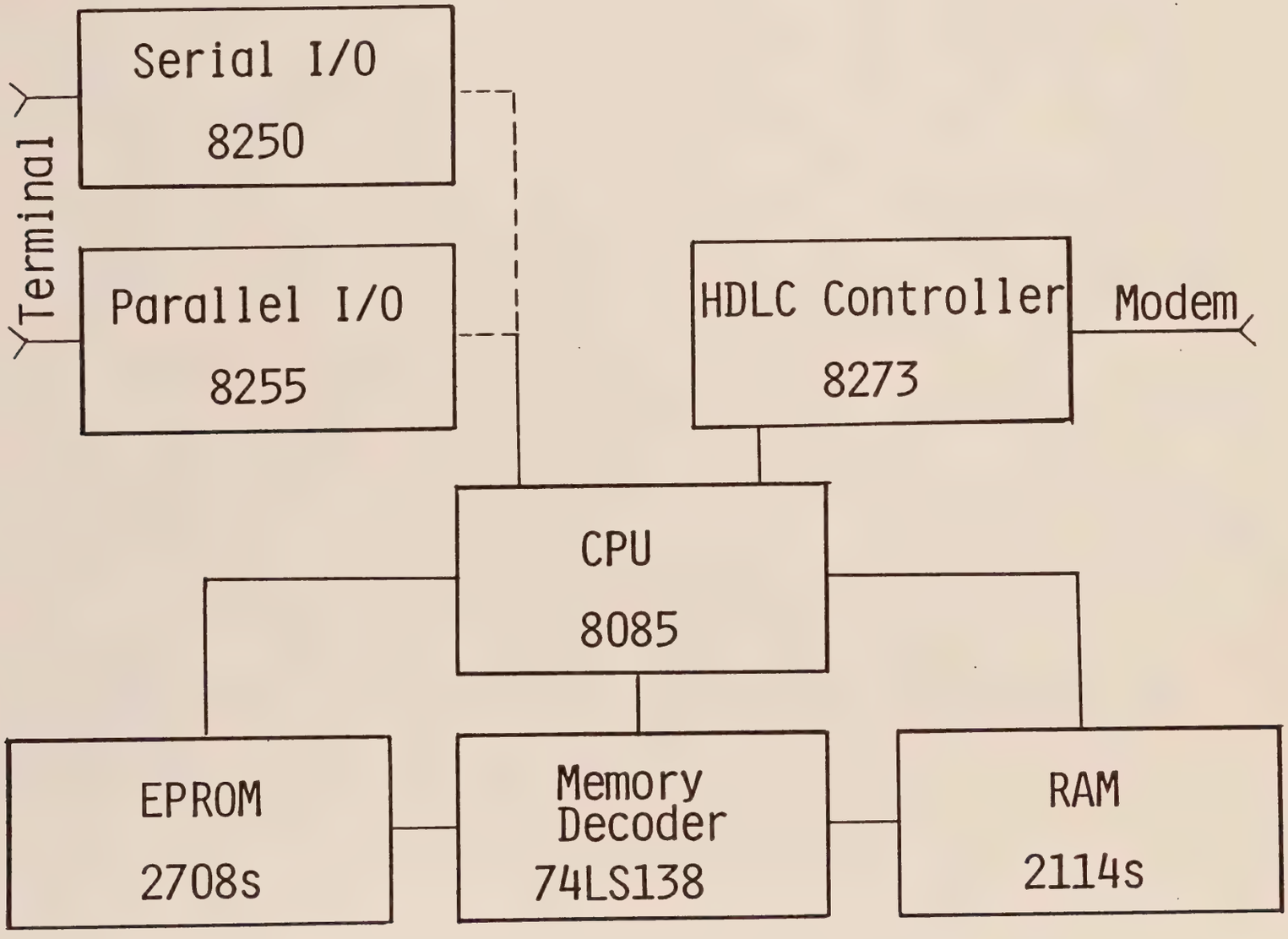
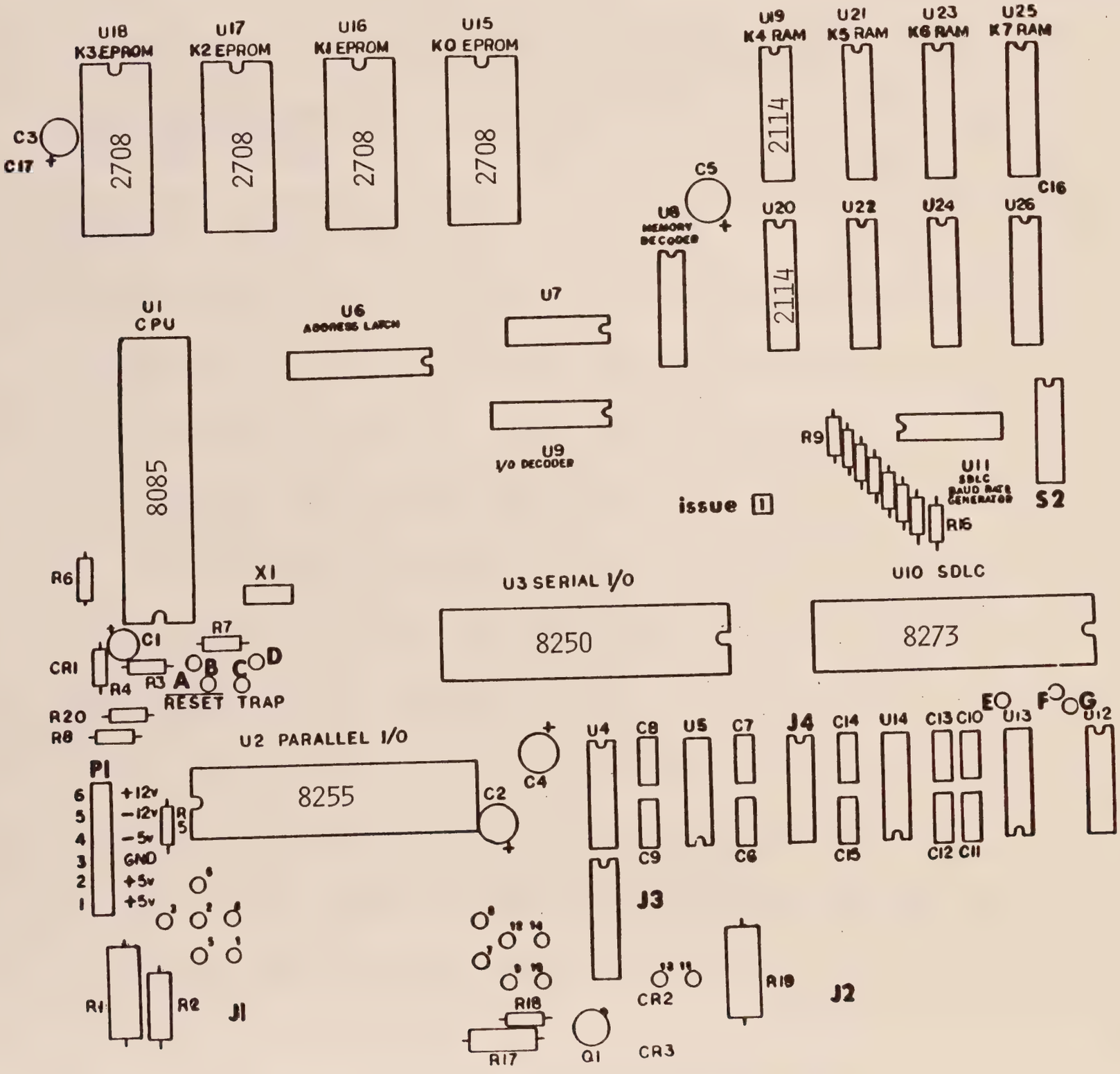
TNC Block Diagram




U18
K3 EPROM
U17
K2 EPROM
U16
K1 EPROM
U15
K0 EPROM
2708
2708
2708
2708
C3
C17
U19
K4 RAM
U21
K5 RAM
U23
K6 RAM
U25
K7 RAM
2114
C16
C5
U8
MEMORY DECODER
U20
U22
U24
U26
2114
U1
CPU
8085
U6
ADDRESS LATCH
U7
U9
I/O DECODER
R9
U11
SDLC BAUD RATE GENERATOR
R16
S2
issue 1
R6
X1
U3 SERIAL I/O
8250
U10 SDLC
8273
C1
R7
CR1
R4
R3
A
B
C
D
RESET TRAP
R20
R8
U2 PARALLEL I/O
8255
C4
C2
P1
6
5
4
3
2
1
+12v
-12v
-5v
GND
+5v
+5v
R5
U4
C8
U5
C7
J4
C14
U14
C13
C10
U13
E
F
G
U12
C9
C6
C15
C12
C11
J3
R1
R2
J1
R18
R17
Q1
CR3
CR2
R19
J2

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TNC Specifications

Terminal Interface:

- TTL, RS-232-C or 20-mA loop signal levels
- Serial (8250) I/O, 0-56 kb/s

  Asynchronous 5, 6, 7 or 8 bits

  Even, odd or no parity

  1, 1.5 or 2 stop bits
- Parallel (8255) I/O, 8-line

Radio Interface: (8273)

- TTL or RS-232-C signal levels
- Asynchronous or self-clocking synchronous
- 600, 1200, 2400, 4800, 9600, 19.2k, 38.4k b/s
- Either NRZI or non-NRZI data

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ISO 3309 HDLC Frame Structure

Flag	Address	Control	Information	FCS	Flag
01111110	8 bits	8 bits	*	16 bits	01111110

*Information field may be any length, omitted in supervisory frames.

- Flags are for frame synchronization.
- Address field may be extended in octets by prior agreement. Last octet has "1" in low-order bit.
- Control field also extensible in octets.
- Frame Check Sequence (FCS) may be extended in octets for higher degree of protection.

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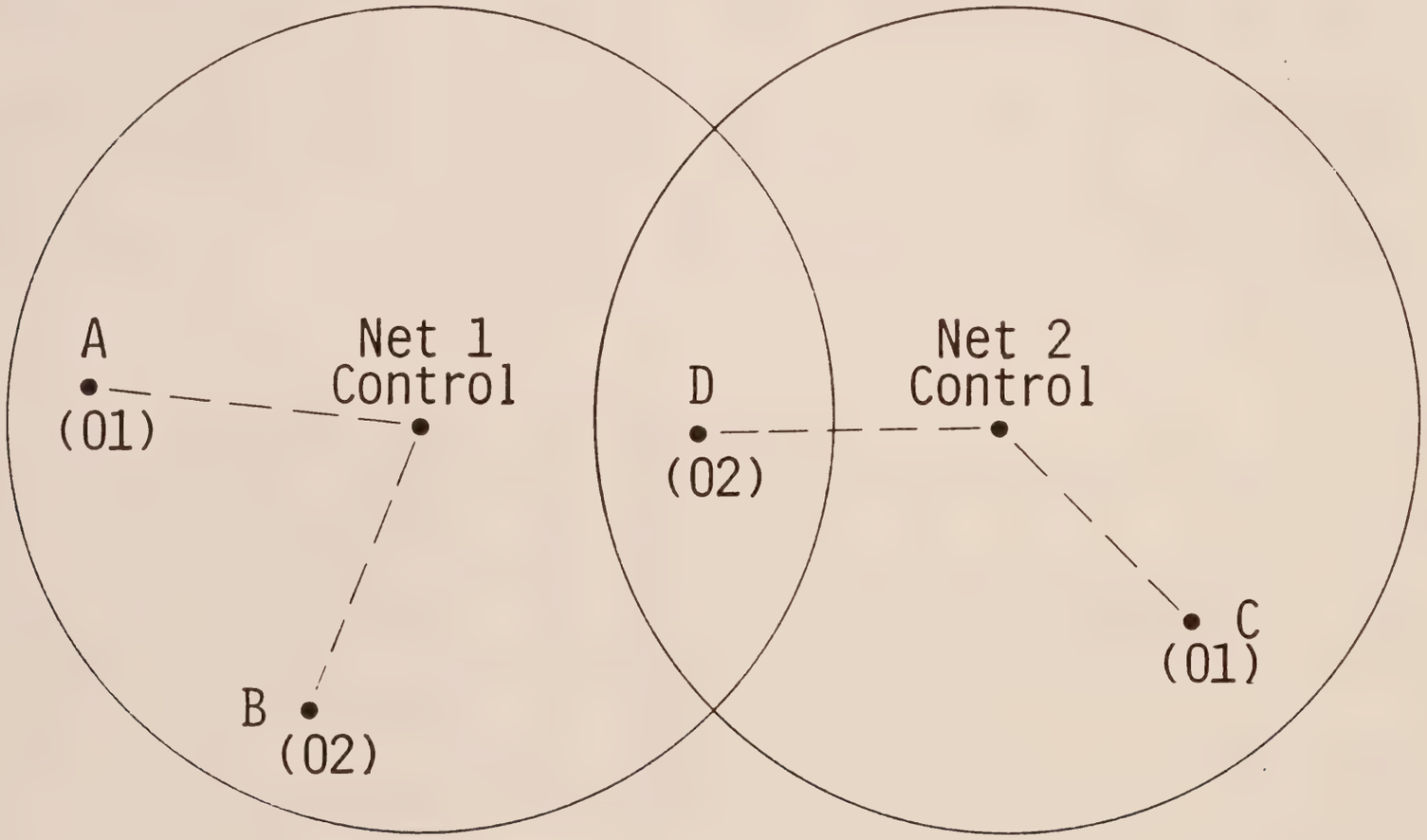
Single-Byte Address Conflict



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WB4JFI HDLC Extended Addressing

Flag	Address	Control	Data	FCS	Flag
01111110		8 bits	variable	16 bits	01111110

10101110	W	BE hex
10000100	B	84
01101000	4	68
10010100	J	94
10001100	F	8C
10010010	I	92
10100101	R	A5

Amateur Call Sign

Qualifier

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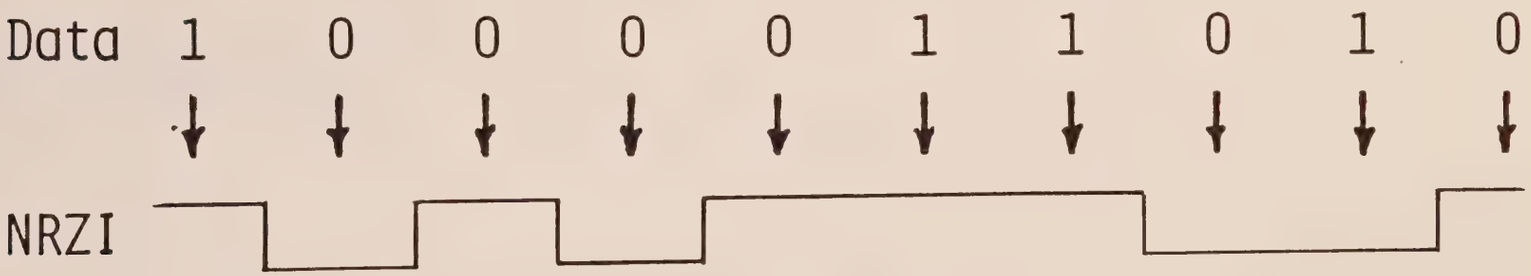
NRZI Coding



- NRZI = Non-Return-to-Zero-Inverted coding.
- Signal condition does not change to send a "1".
- Binary "0" causes a change in state.
- NRZI guarantees that channel has a transition every 5-bit times.
- Long strings of zeros cause transition every bit time.
- Long strings of ones are broken by zero bit insertion.

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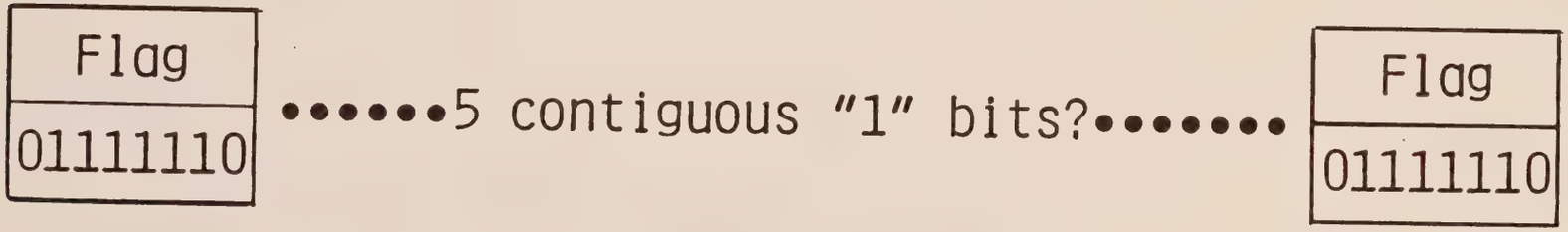
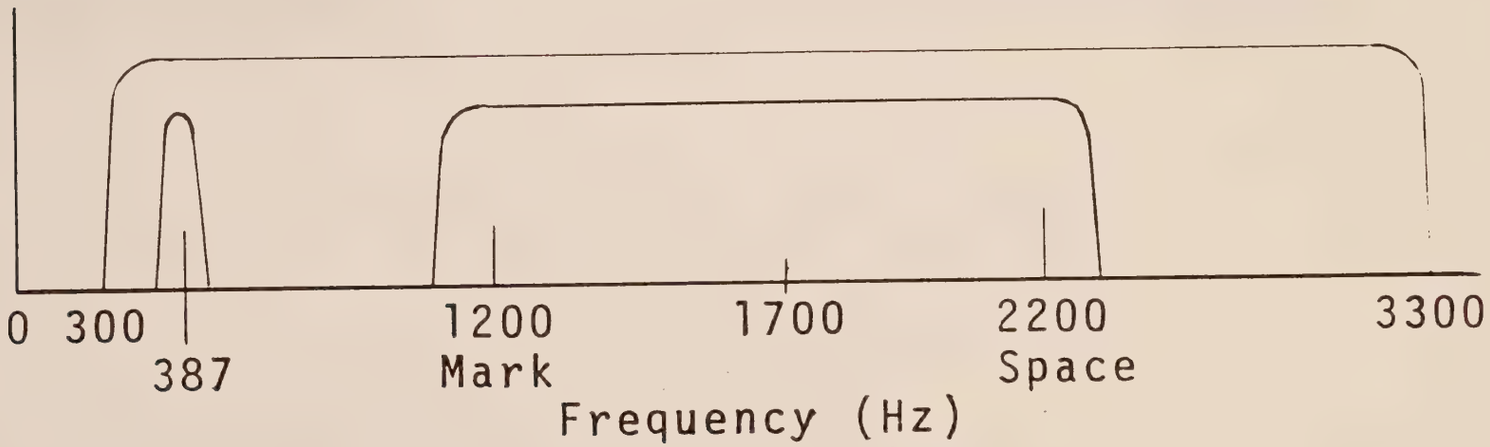
Bit Sequence Transparency



- The transmitter examines content between flags and inserts a "0" bit after all sequences of contiguous "1" bits to ensure that a flag sequence is not simulated. (Known as "bit stuffing").

- The receiver discards any "0" bit which directly follows 5 contiguous "1" bits which occur between the flag sequences.

AMRAD Bell 202 Modem Specifications



- Data : Serial, binary, asynchronous, half duplex
- Data Transfer Rate: 0-1200 or 0-1800 b/s
  Optional 5-b/s reverse channel
- Modulation : Frequency-shift keying (fsk)

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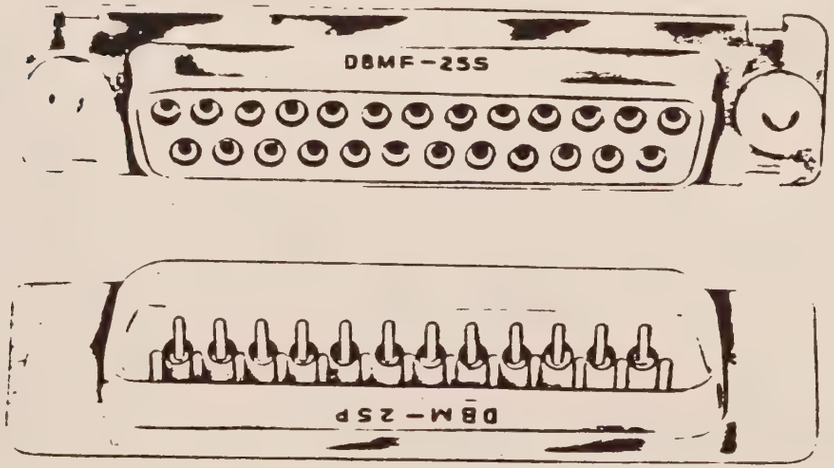
D Subminiature Connectors



- DB-25 used for RS-232-C connections such as modem to terminal or computer serial port.

- Data cables make excellent antennas. Shielded wire and metal hoods are advised.

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Modem Handshaking Signals

Control Signal	Pin	Function
Transmitted Data	2	Serial data, device to modem
Received Data	3	Serial data, modem to device
Request to Send	4	Set when device wants to send
Clear to Send	5	Set by modem when transmission may commence
Data Set Ready	6	Set by modem when ready to transfer data, response to DTR
Carrier Detect	8	Set by modem when signal present
Data Terminal Ready	20	Set by device to enable modem to answer incoming call
Ring Indicator	22	Set by modem when telephone rings

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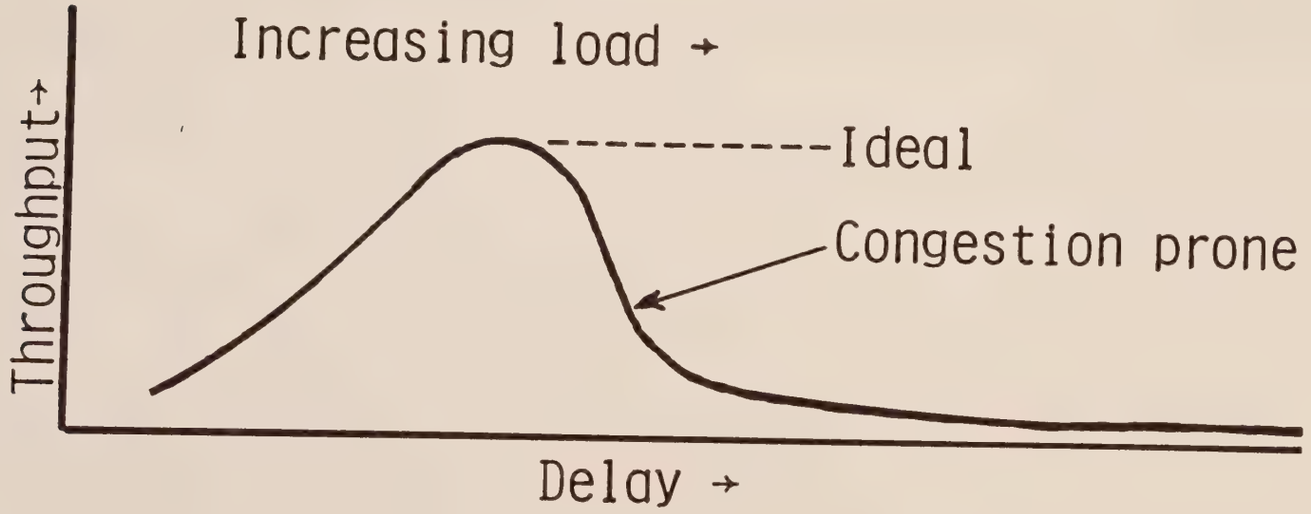
Congestion and Flow Control



- In ideal system, throughput would remain constant, only delay increases, under increasing load.
- No perfect solution -- major research area.
- Value of reserve capacity and minimizing overhead and unnecessary transmissions.

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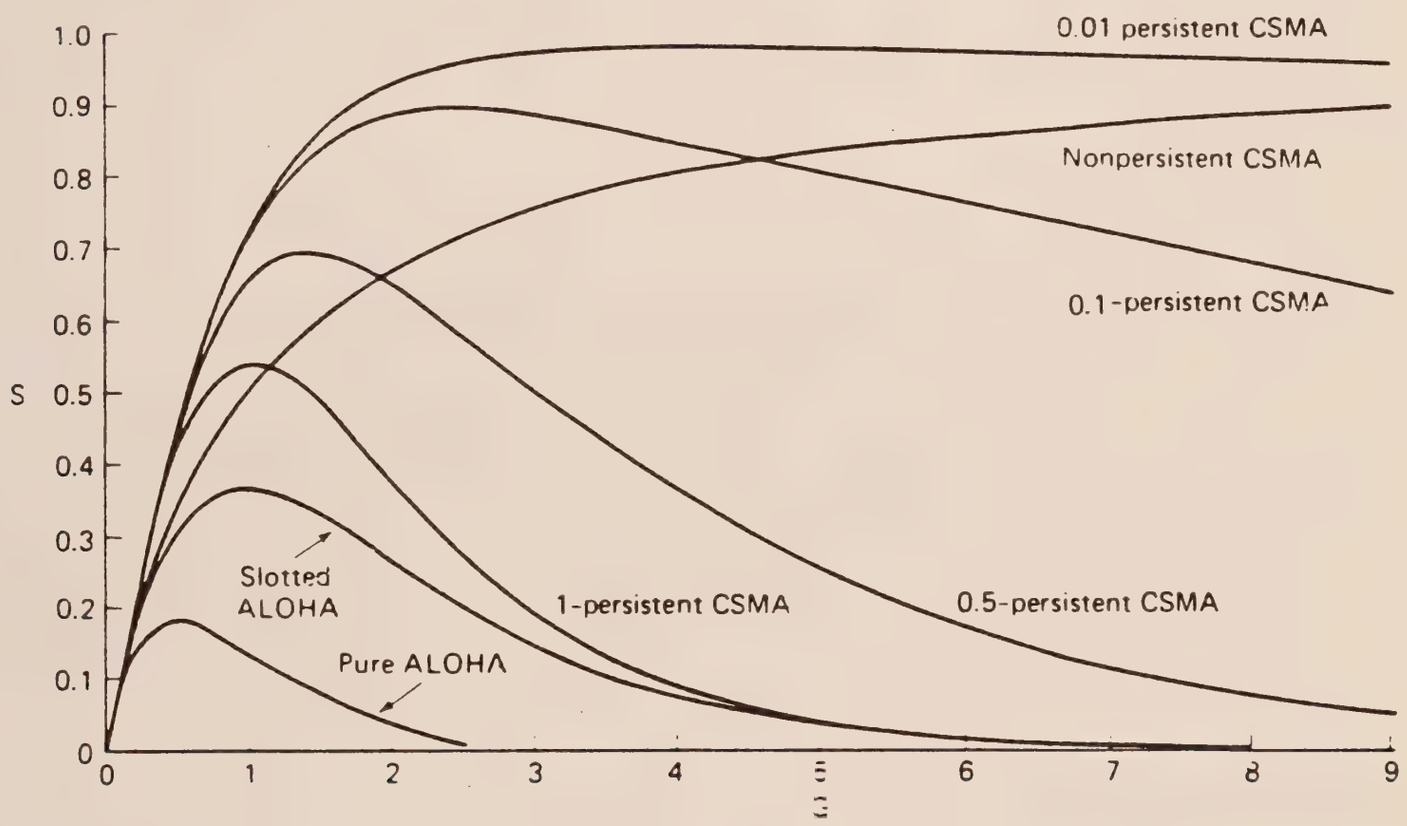
Utilization vs. Loading for Various Contention Schemes



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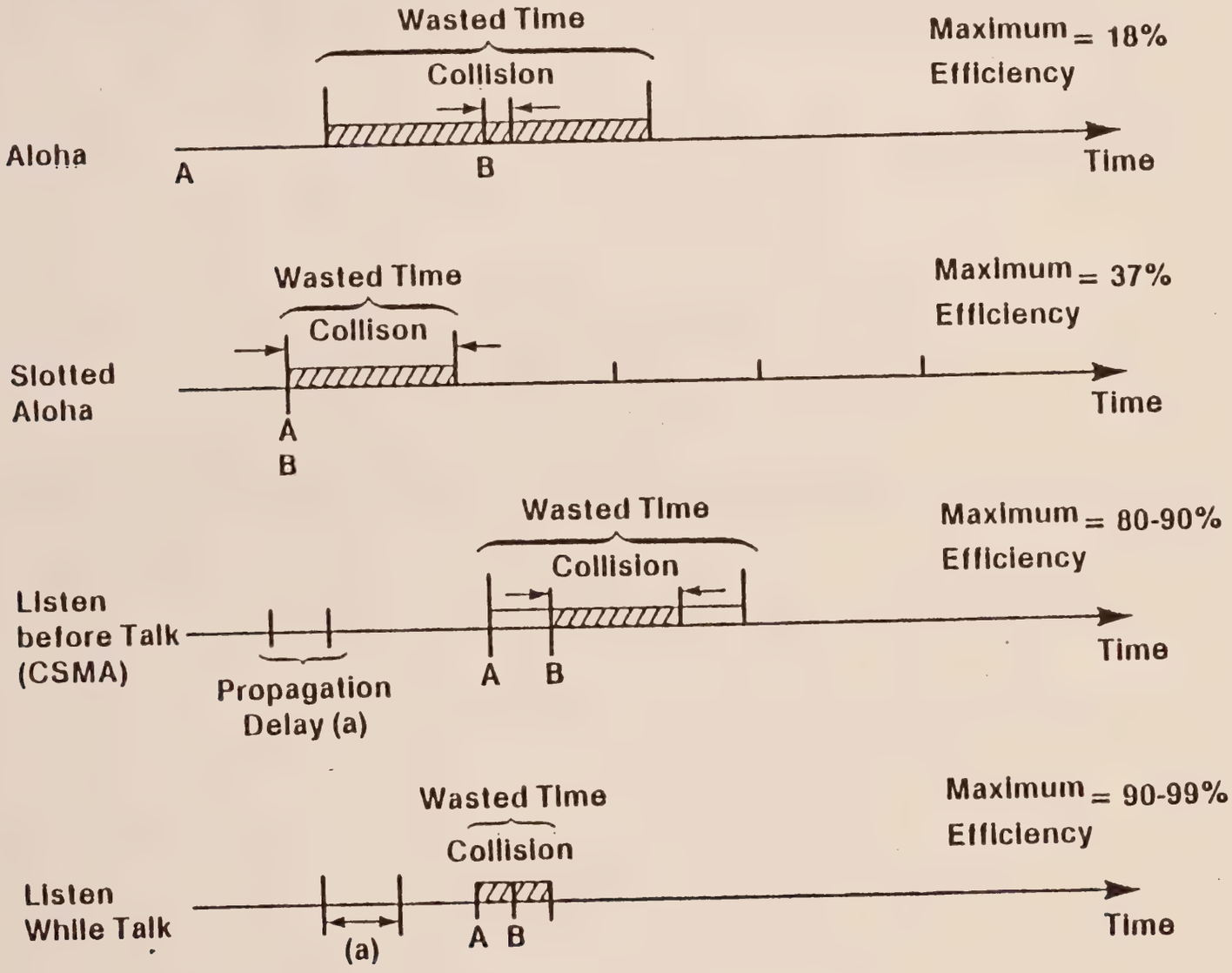
Efficiency vs. Contention Scheme



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Standards Organizations

CCITT	International Telephone and Telegraph Consultative Committee
ISO	International Organization for Standardization
ANSI	American National Standards Institute
EIA	Electronic Industries Association

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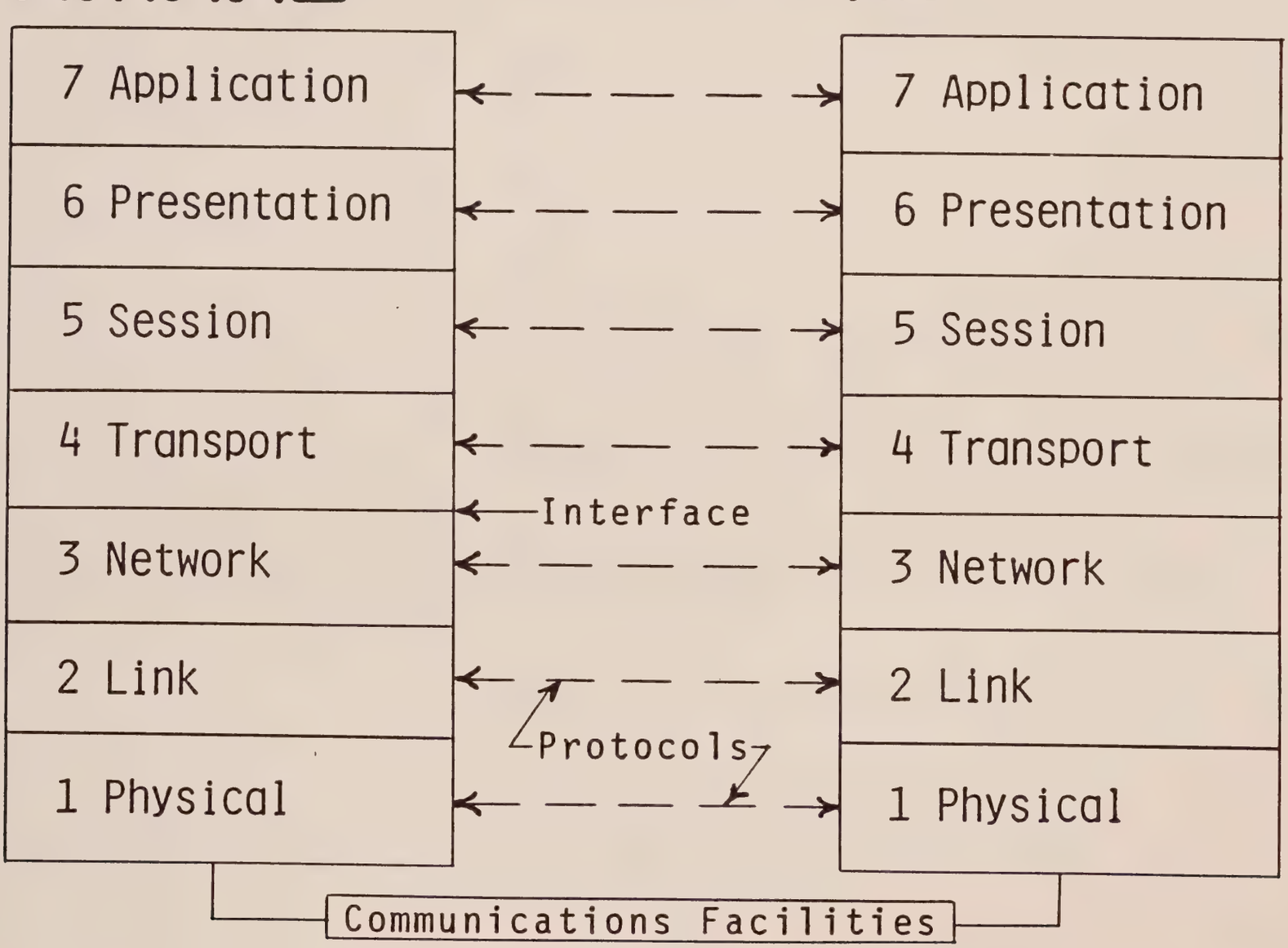
ISO Layers
7 Application
6 Presentation
5 Session
4 Transport
Interface
3 Network
2 Link
1 Physical
Protocols
7 Application
6 Presentation
5 Session
4 Transport
3 Network
2 Link
1 Physical
Communications Facilities

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Layer Functions

7 Application	End-user protocols (file-transfer program)
6 Presentation	Data structure, display, codes (ANSI ASCII)
5 Session	Transmission initiation and termination, data flow control
4 Transport	Reconstructs messages from blocks (ARPA TCP, NBS Transport Proto.)
3 Network	Addressing, multiplexing, flow (CCITT X.25)
2 Link	Link start/stop, sequencing, error control (ISO HDLC)
1 Physical	Electrical signaling (bits) (EIA RS-232-C, CCITT V.24)

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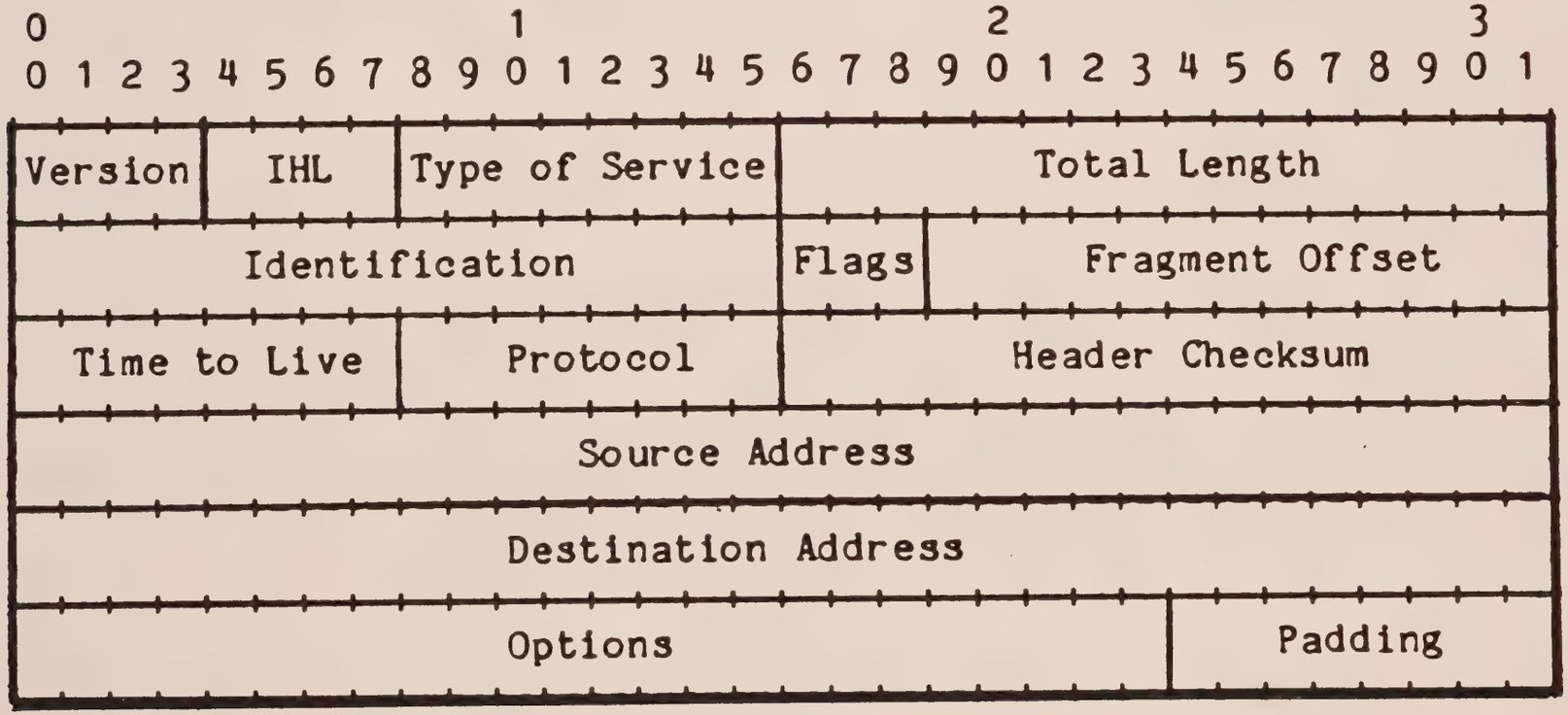
DoD Internet Datagram Header



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Virtual Circuit vs. Datagram

Issue	Virtual Circuit	Datagram
Destination address	Needed during setup	Need in every packet
Error handling	Done in network layer	Done by host in transport layer
End-to-end flow control	Done in network layer	Not provided in network layer
Packet sequencing	Messages always passed to transport layer in the order sent	Messages passed to the transport layer in the order they arrive
Initial set-up procedure	Virtual call requires set up. None needed for permanent virtual circuit.	Not possible

AMRAD Proposed 220-MHz Packet Channels

Frequencies	Proposed Packet Use
220.6/221.6 220.7/221.7 220.8/221.8	Repeater pairs
220.9 221.0 221.1 221.2 221.3 221.4 221.5	Simplex operations

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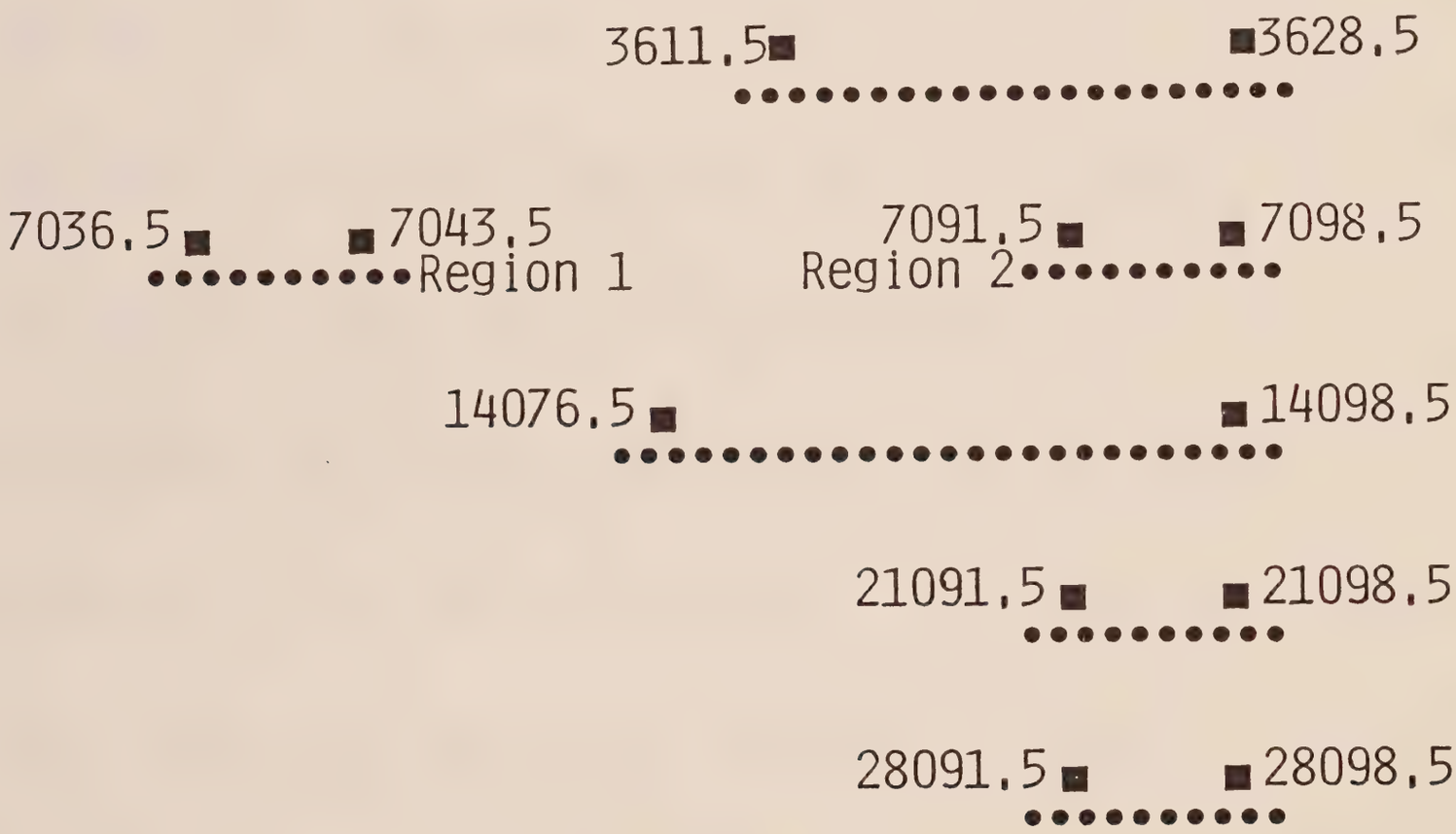
Proposed Packet HF Channels



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R& for HF Packets

- Maximum legal transmitter power
- Directional antenna(s) (20-10 meters)
- Frequency agility (max S/N, min multipath)
- Signaling speed agility (50-600 baud)
- Frequency diversity (600-Hz vs. 170-Hz shift)
- Diversity receivers & antennas (h & v polarization)
- ARQ (ACK/NAK) for point-to-point circuits
- FEC for burst errors (broadcasts, nets)

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Packet Controller Hardware

User	Existing Hardware
Individual	VADCG Terminal Node Controller Board TAPR Terminal Node Controller Board
Network	STD Bus Packet Board S-100 (IEEE 696) Bus Packet Board

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TNC Features

- User employs to port into Local Area Network (LAN)

- Board handles:
  - Some serial device
    - +Terminal
    - +Printer
    - +Computer
  - Modem/transceiver
    - +Makes packets
    - +Handles T/R switching

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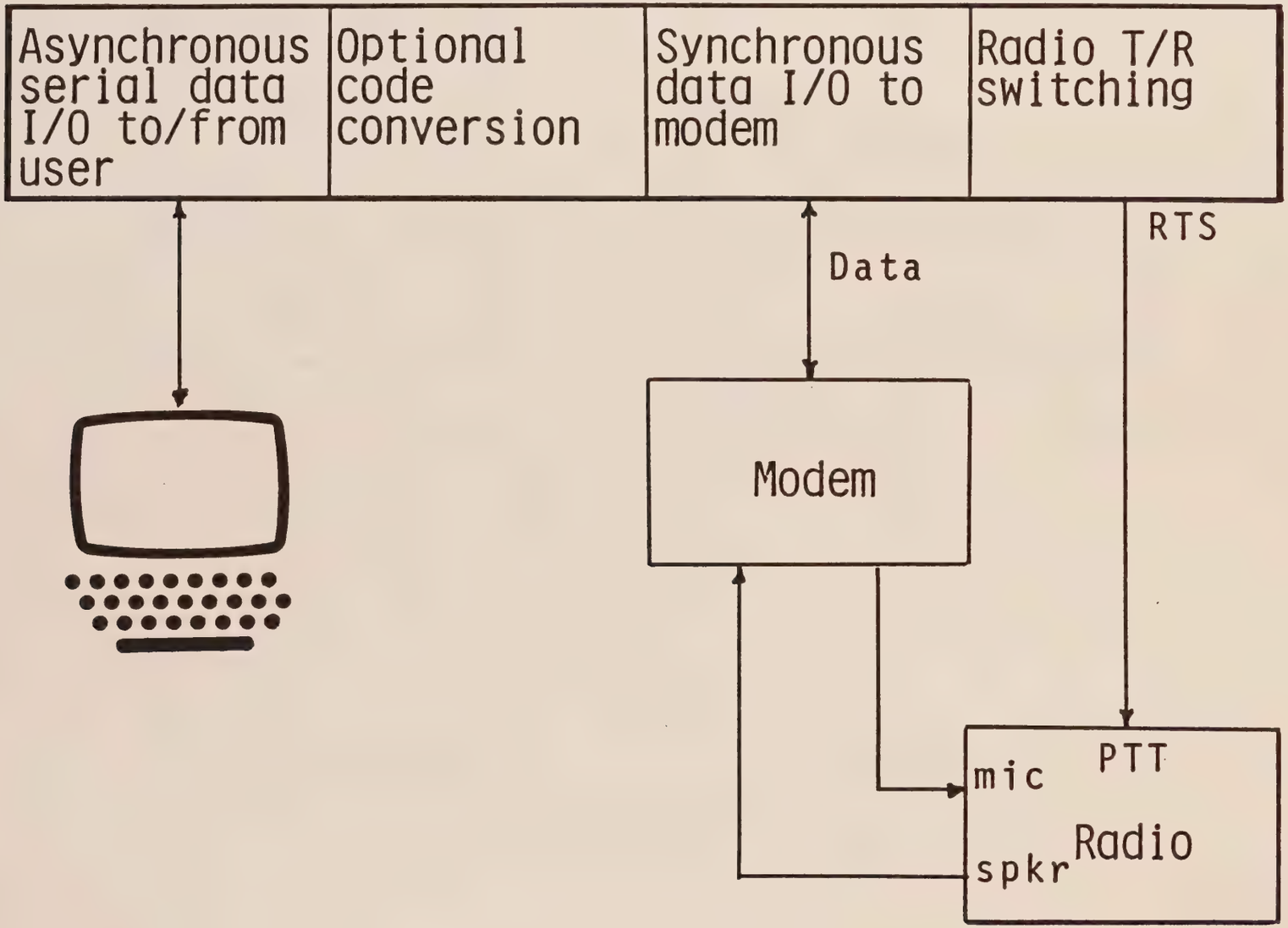
TNC Functions



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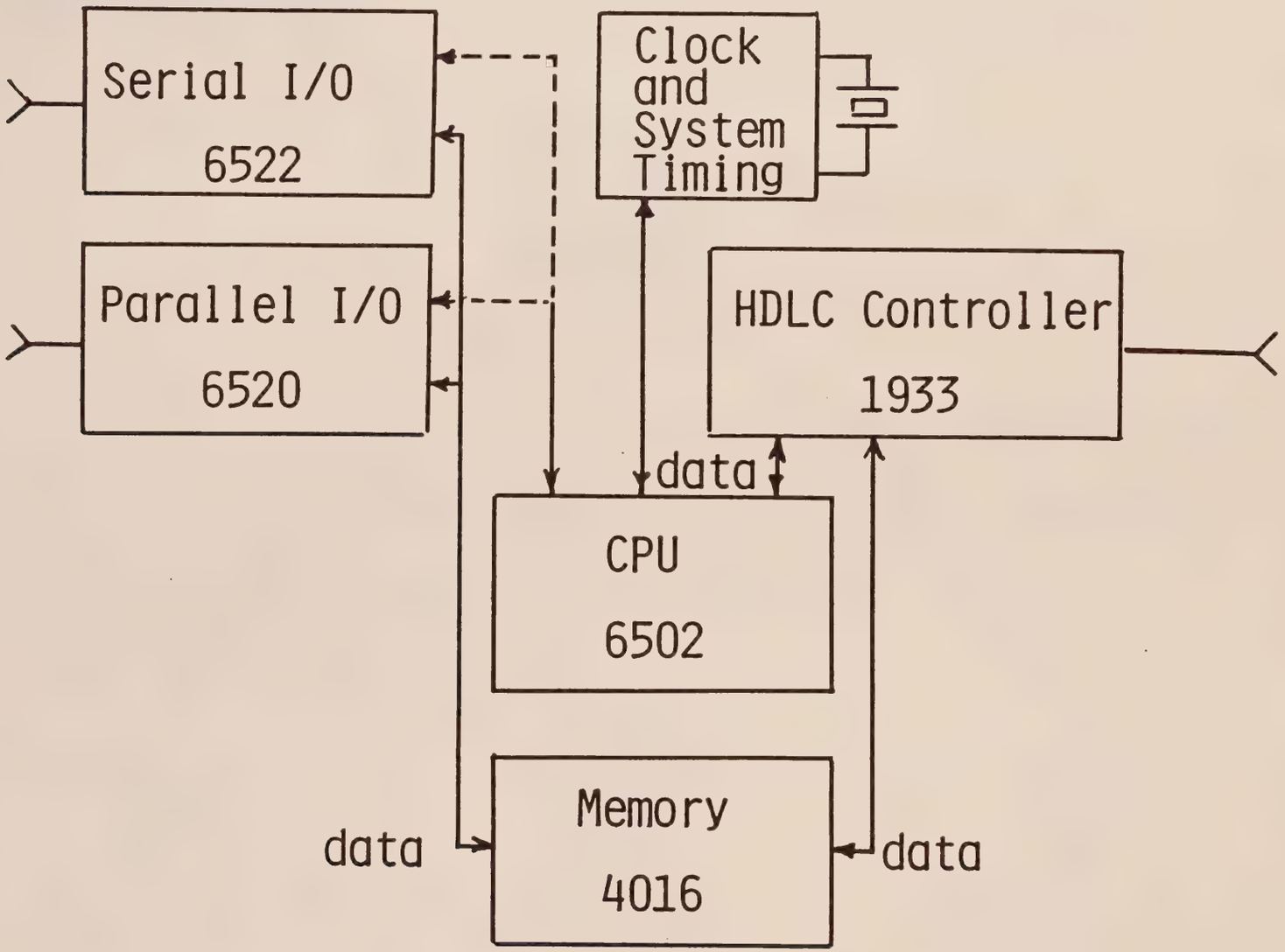
TAPR TNC Block Diagram



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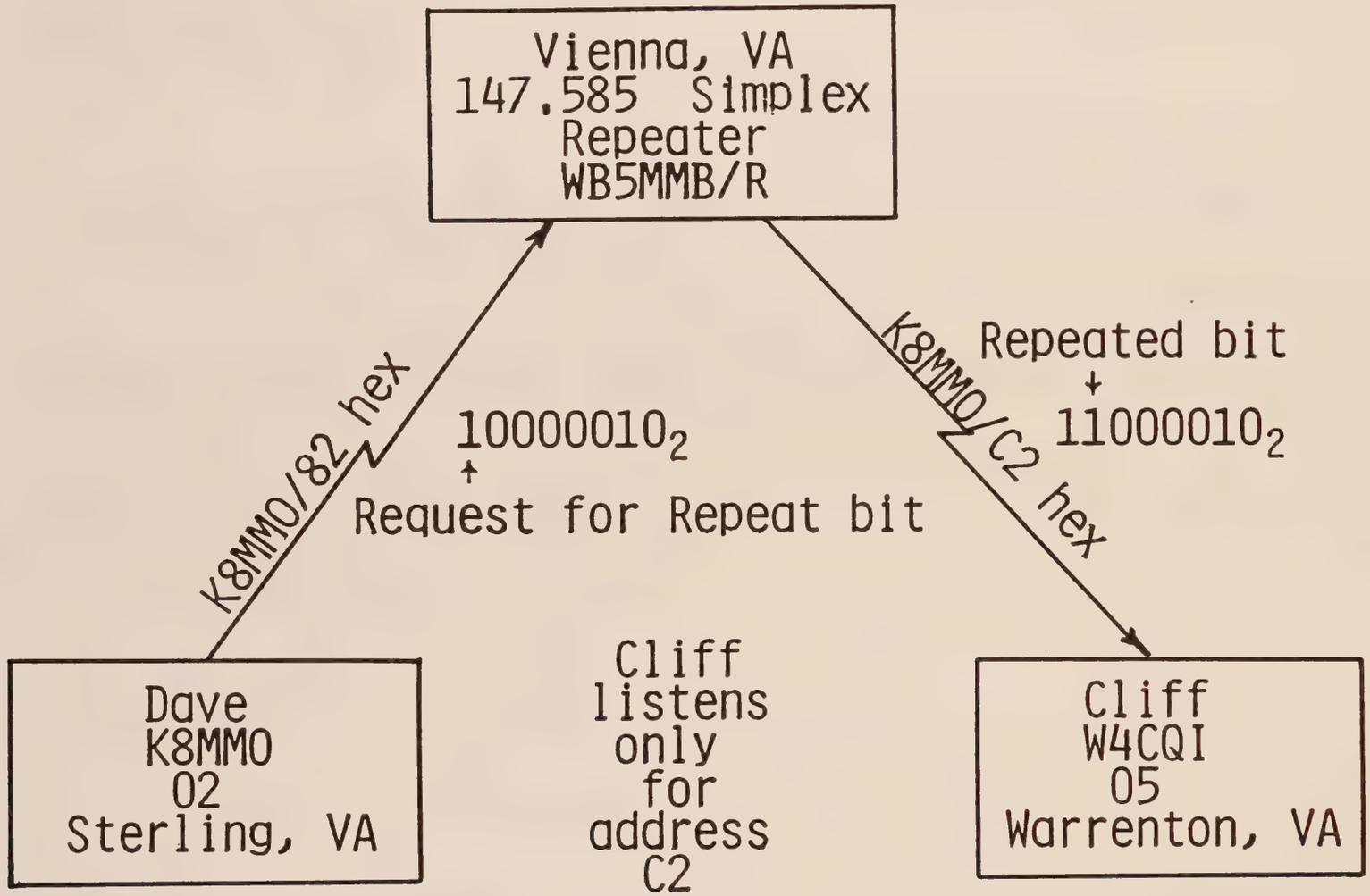
Request for/Repeater Bits



AMRAD Station Node Controller

- Server employs SNC to connect Local Area Network to backbone network
- Single packet board plugs into existing computer
- Two types now in use:
  - STD bus
  - S-100 bus

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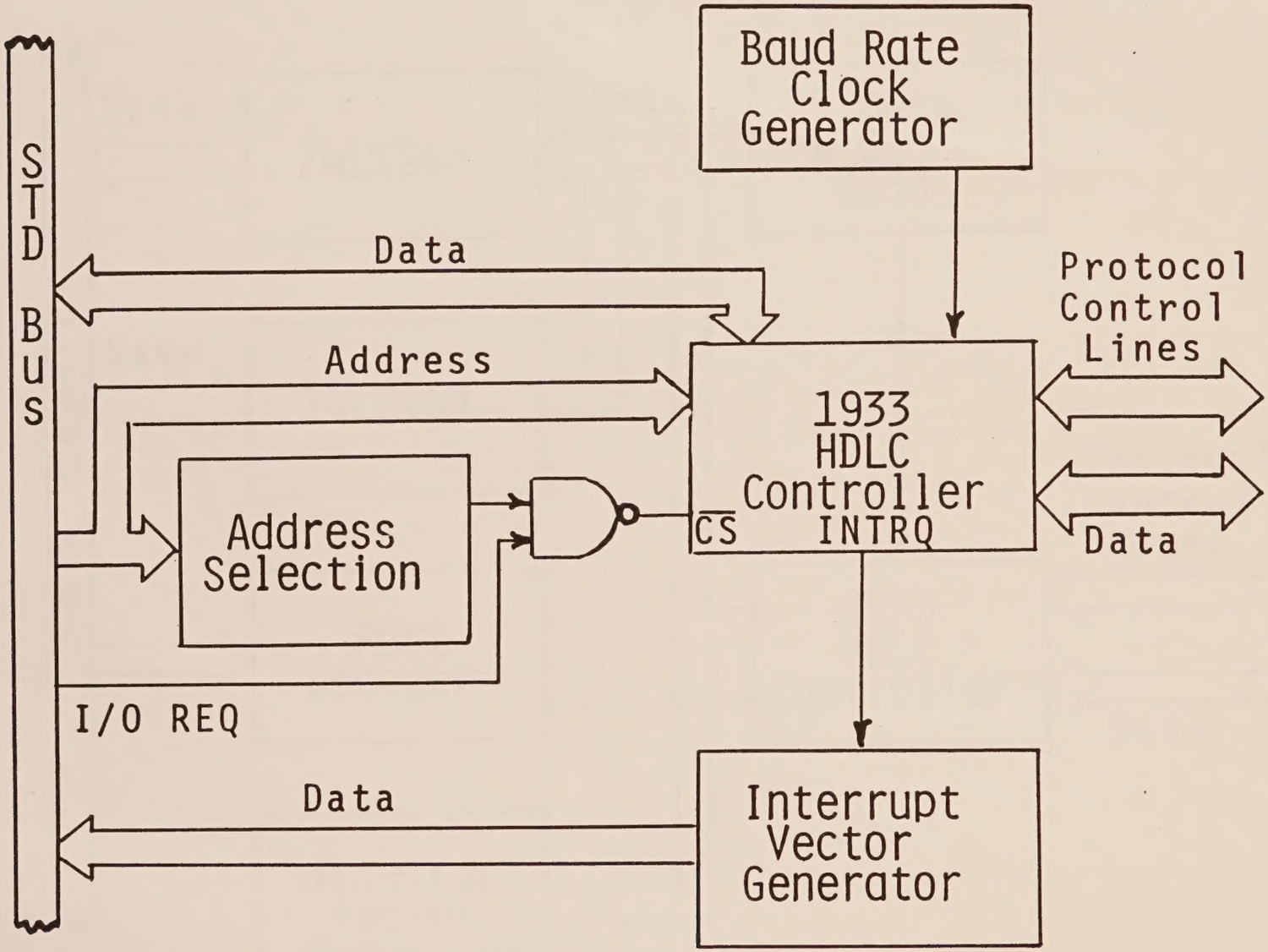
STD SNC Block Diagram



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S-100 SNC Block Diagram